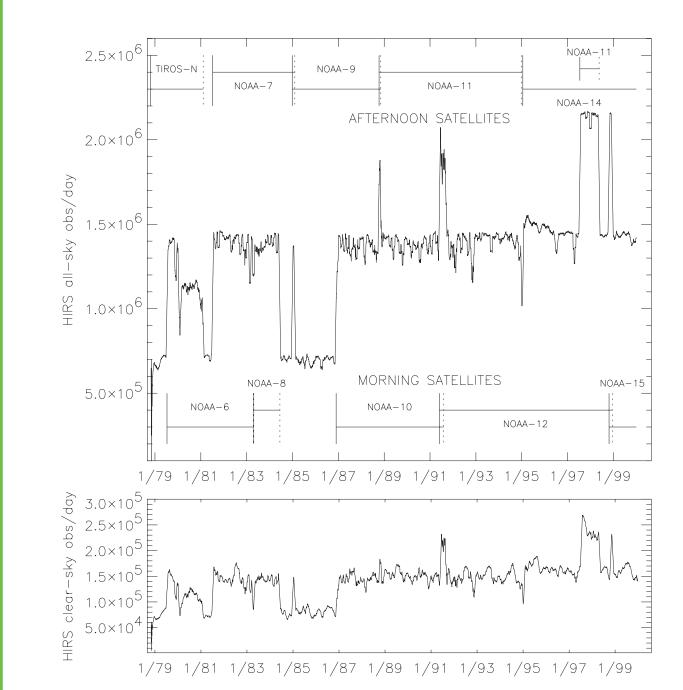
INTRODUCTION

The HIRS Pathfinder data contains one of the largest global set of temperature, water vapor and ozone observations in the weather community. These observations have been collected from 11 NOAA polar-orbiting operational satellites since October of 1978. Since the original intent for these observations was for operational weather analysis, climate analysis with these data must be done carefully so to maintain consistency through out the data. Our first processing of all the HIRS 1b data attempts to remove clouds from these observations since most HIRS channels are sensitive to the presence of clouds. Following cloud removal, we compare our results with the NESDIS sounding retrievals and investigate the intersatellite bias observed in many channels.

THE DATA



This figure indicates the amount of HIRS 1b data processed and the origin of those data.

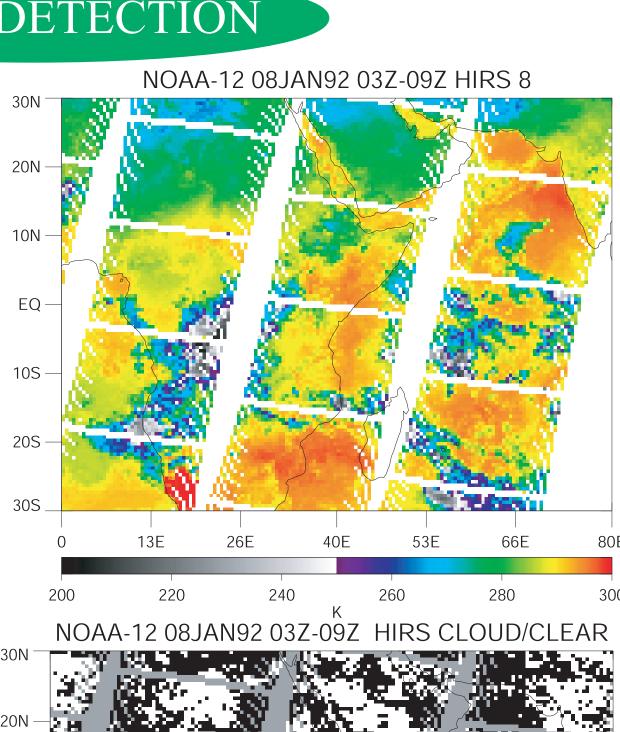
- 1. The total number of observations remains nearly steady after deployment of NOAA-10. NOAA-8 had an early HIRS failure that contributed to a two year gap in the morning satellites.
- 2. Satellites show increasingly longer life spans in more recent years.
- 3. Spikes are associated with overlap periods between newly deployed and old satellites.
- 4. Clear-sky data is nearly a one order of magnitude reduction in data.

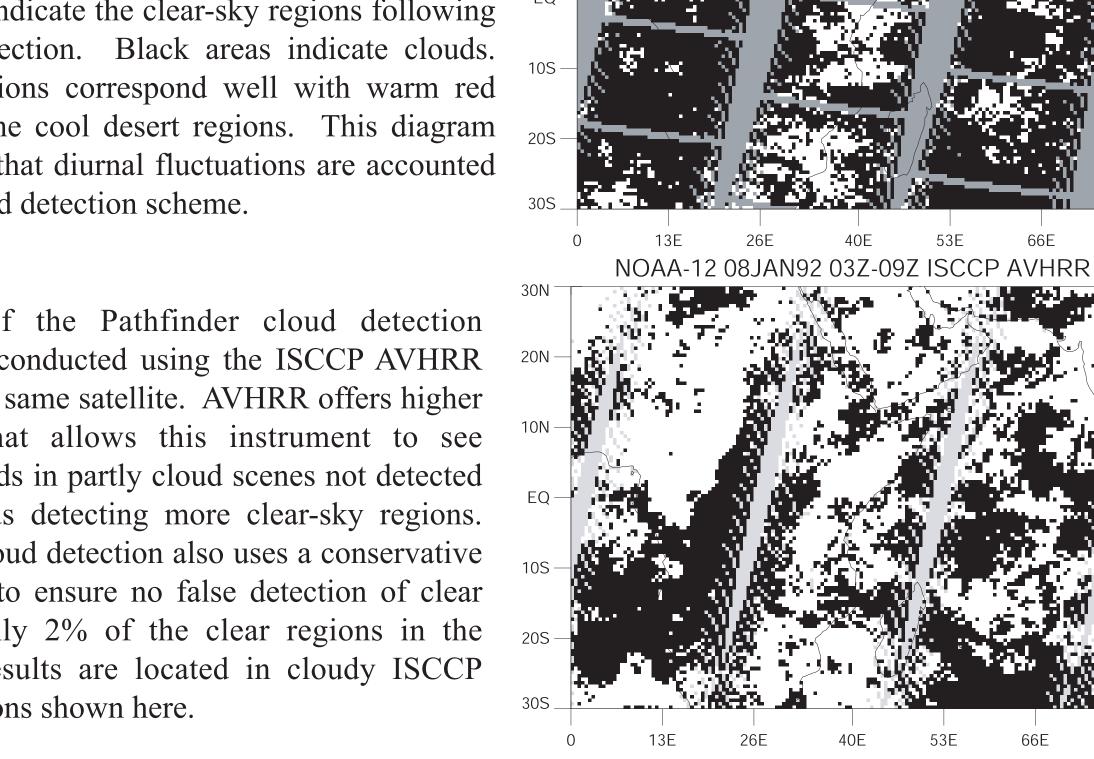
CLOUD DETECTION

HIRS channel 8 observations detect surface 20N 1 temperature in the absence of clouds. This figure shows three descending morning orbits over Western 10N-Africa. Blue and grey regions over eastern Africa and the Indian Ocean indicate cold high convective clouds. Green and blue regions over the deserts of Africa and Arabia indicate a relatively cold surface. Land/sea contrast seen on the western coast of India illustrate diurnal temperature differences between ocean and land.

An ISCCP-type cloud removal approach was adopted for this study. Large variations, in time and space, in the HIRS 8 observations were used to detect clouds. Brightness temperature thresholds were established to detect clouds. White regions in this diagram indicate the clear-sky regions following the cloud detection. Black areas indicate clouds. Clear-sky regions correspond well with warm red regions and the cool desert regions. This diagram demonstrates that diurnal fluctuations are accounted for in the cloud detection scheme.

Validation of the Pathfinder cloud detection method was conducted using the ISCCP AVHRR data from the same satellite. AVHRR offers higher resolution that allows this instrument to see between clouds in partly cloud scenes not detected by HIRS thus detecting more clear-sky regions. Pathfinder cloud detection also uses a conservative approach so to ensure no false detection of clear regions. Only 2% of the clear regions in the Pathfinder results are located in cloudy ISCCP detected regions shown here.





CIRES

IN ENVIRONMENTAL SCIENCES

-14.0 -8.4 -2.8 2.8 8.4 14.0

Channel 2 senses stratospheric

temperatures (30 hPa). The summer

hemisphere is warmest particularly at

high latitudes. North Pacific warm

region is caused by a sudden

Largest differences are detected in the

zonal mean differences between 50N

and 70N. These differences are greatest

over the North Pacific and North

Atlantic where both data sets have very

few samples due to cloud cover.

stratospheric warming event.

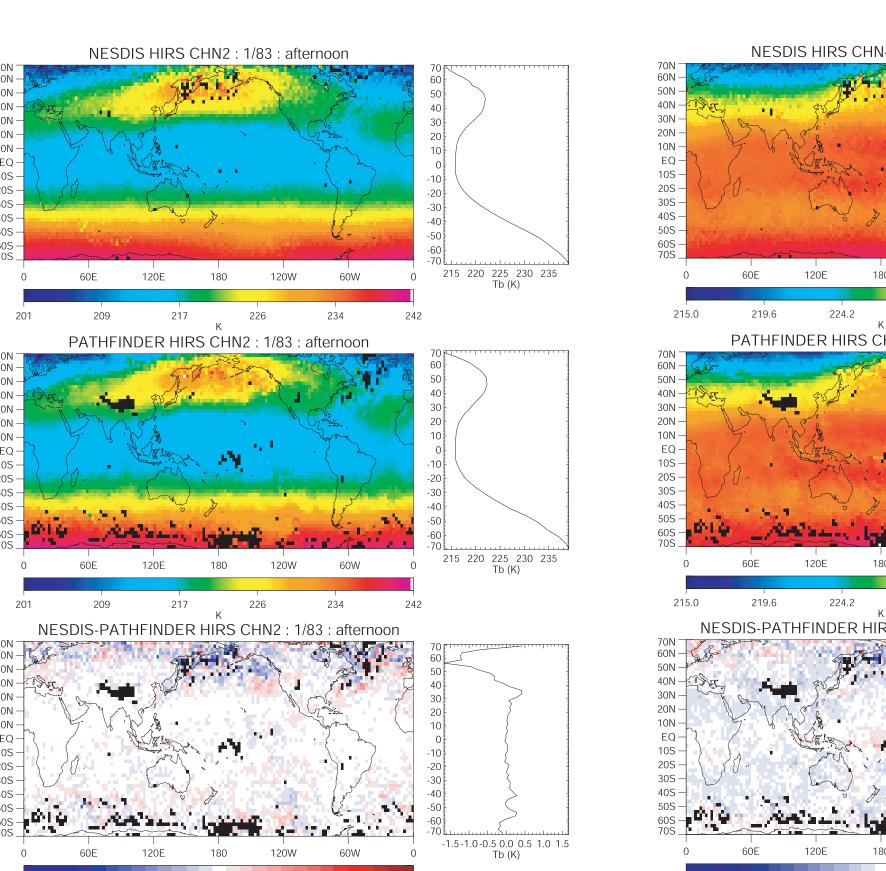
Climate Analysis with the 21-yr HIRS Pathfinder radiance clear-sky data set

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PATHFINDER/NESDIS COMPARISON



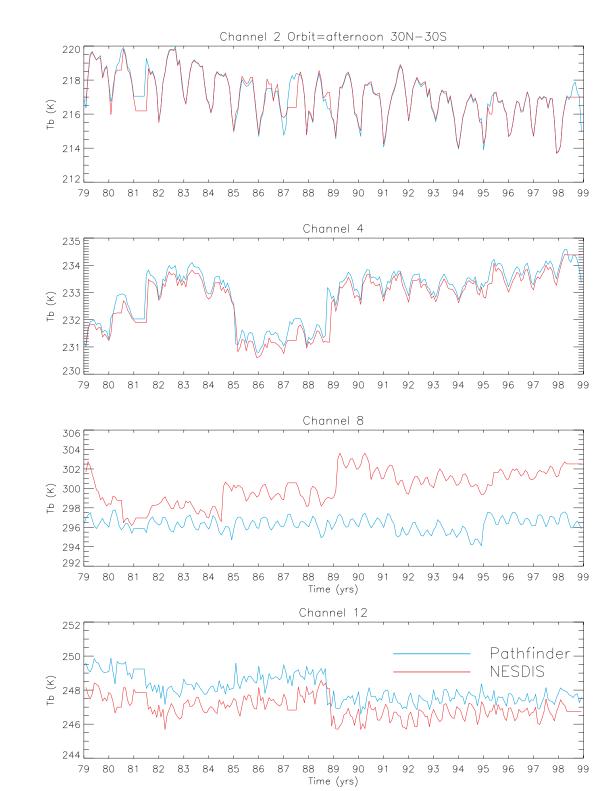
0 60E 120E 180 120W 60W 0 220 225 230 235 240 215.0 219.6 224.2 228.8 233.4 238.0 0 60E 120E 180 120W 60W 0 Th (K) coefficients resulted in changes to the cloud detection method. In 1989, 215.0 219.6 224.2 228.8 233.4 238.0 change in the channel 10 central frequency resulted in changes in the HIRS 8 temperature adjustment. Pathfinder shows NOAA-11 orbital drift to the morning orbit in the early 1990's. Channel 12 shows an unexplained bias between the two data sets.

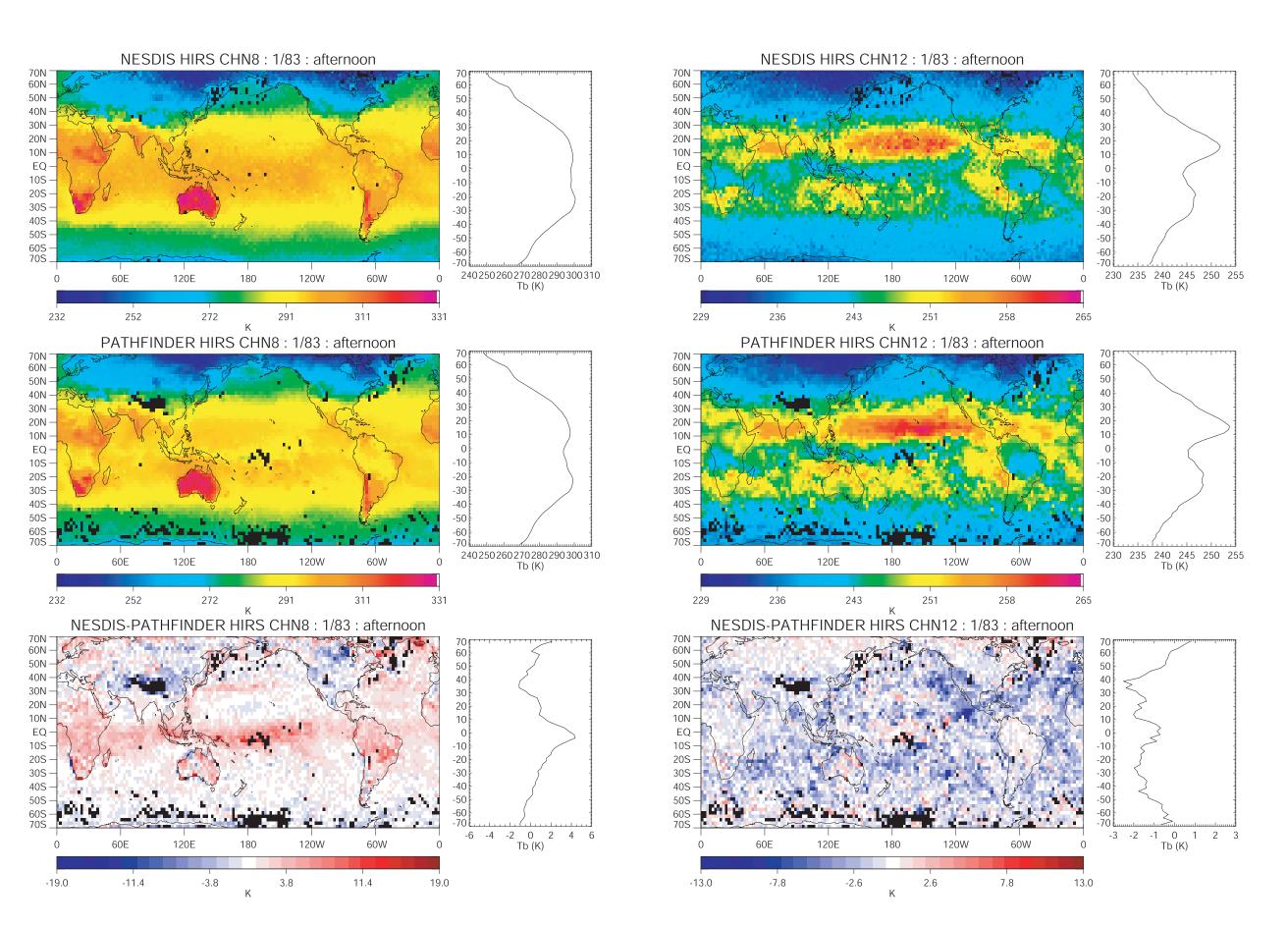
Channel 4 senses upper tropospheric temperature (400 hPa). The summer hemisphere is warmer at high latitudes due to greater solar insolation.

-8.0 -4.8 -1.6 1.6 4.8 8.0

Largest differences occur near 70N as is shown for channel 2. A small bias exist in the mid-latitudes in all regions. The positive difference over the tropical central Pacific are related to cloud detection differences over deep tropical convection. Also note the significant number of missing data areas between 50S and 70S in the Pathfinder data.

Comparing the HIRS Pathfinder clear-sky results with the NESDI operational sounding products exposes strengths and weaknesses fr both data. Both data sets were originally derived from from the TOVS data. Global maps illustrate the differences seen between these data i four HIRS channels. Zonal averages accompany each global map. A 20 yr time series for 30N-30S for each channel from both data sets is given Negative trends for channel 2 in both data sets indicate observed stratospheric cooling. Channel 4 indicates good agreement between the two data sets. Jumps indicate bias caused by transitions between satellites. Channel 8 reveals operational changes in the NESDIS operational processing method. In 1984, changes made to the transmittance





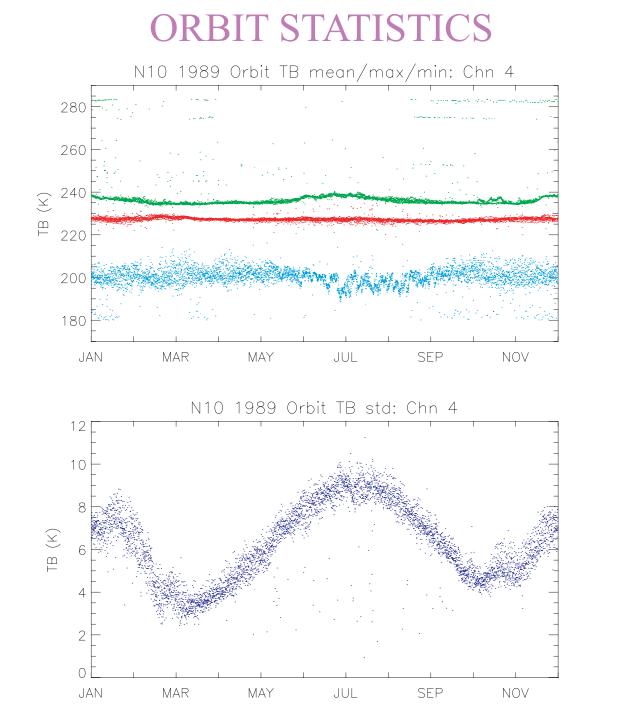
Channel 8 senses surface temperature. Afternoon orbits detect warm land masses in the summer hemisphere.

Largest differences occur in the tropical convective regions. Pathfinder indicates colder values in these regions likely due to cloud detection differences with NESDIS Land areas show larger differences than ocean areas. Adjustments made the channel 8 in the NESDIS operational scheme likely contribute to the land/sea differences.

Channel 12 senses upper tropospheric water vapor (300 hPa). Warm region over the central Pacific indicates very dry region associated with seasonal cycle and the strong El Nino event of 1982/83.

Differences are generally negative and at all latitudes. Zonal difference diagrams indicate the subtropical regions have the largest differences. Time series indicates this 1 K difference to exist over the 20 year record.

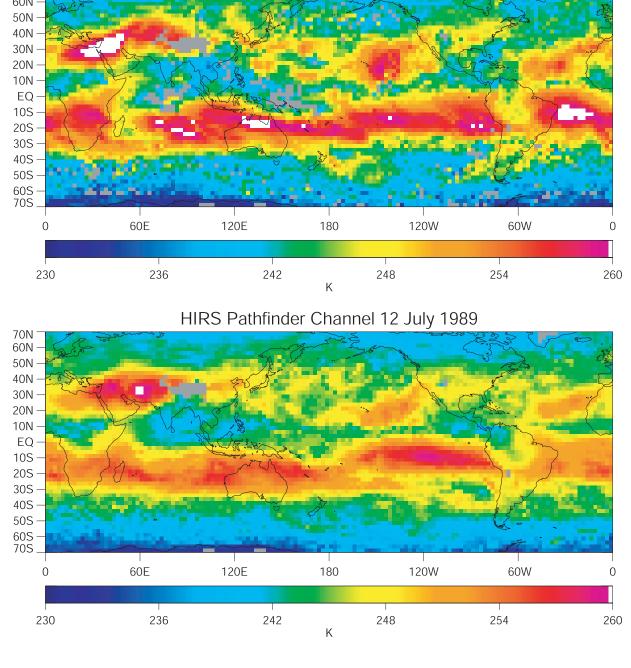
PRODUCTS



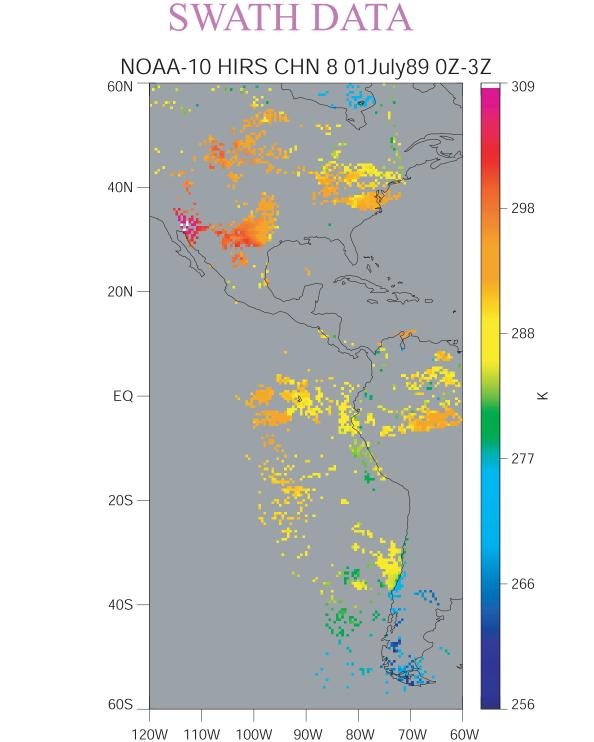
All-sky statistics for each orbit, satellite, channel

GRID DATA

HIRS Pathfinder Channel 12 15 Jul 89-19 Jul 89

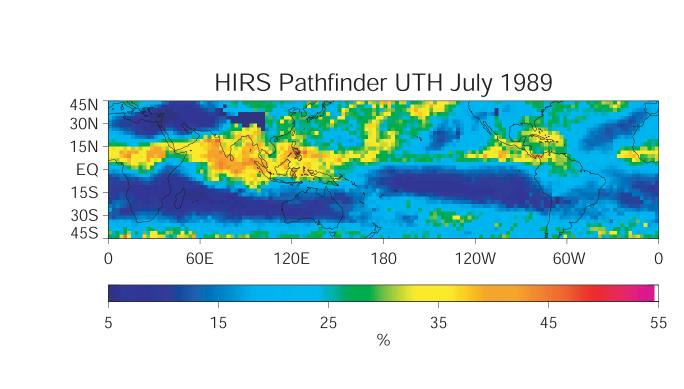


Pentad and monthly mean clear-sky data grids for each satellite and channel.



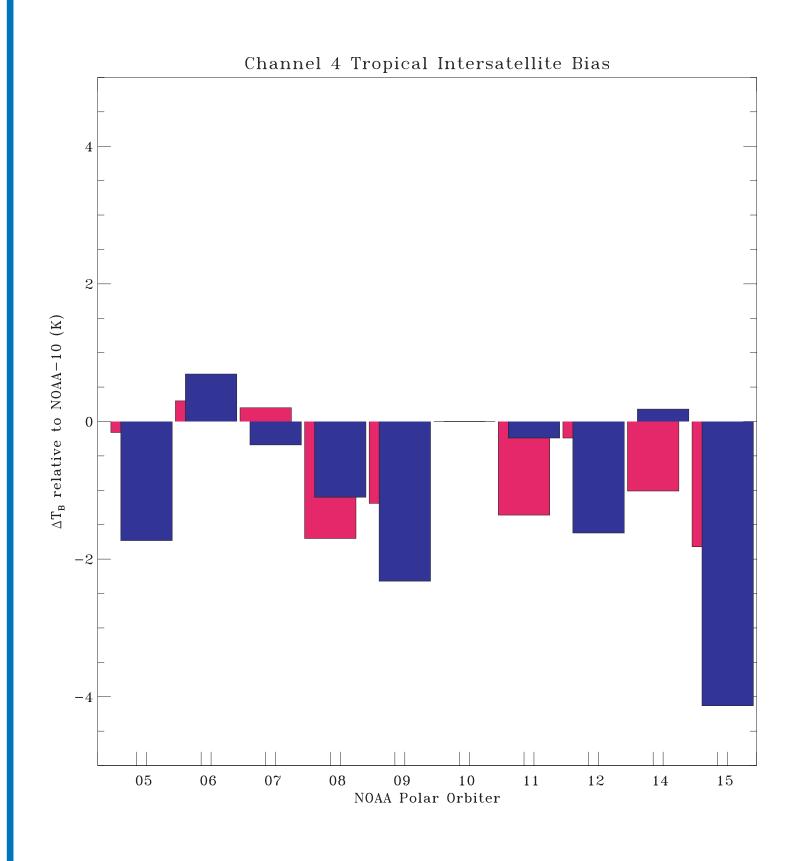
Clear-sky data at the resolution of HIRS field-of-view. Data record contains longitude, latitude, solar zenith, altitude, reflectance, spot position, and angledependent brightness temperatures.

RETRIEVED PRODUCTS

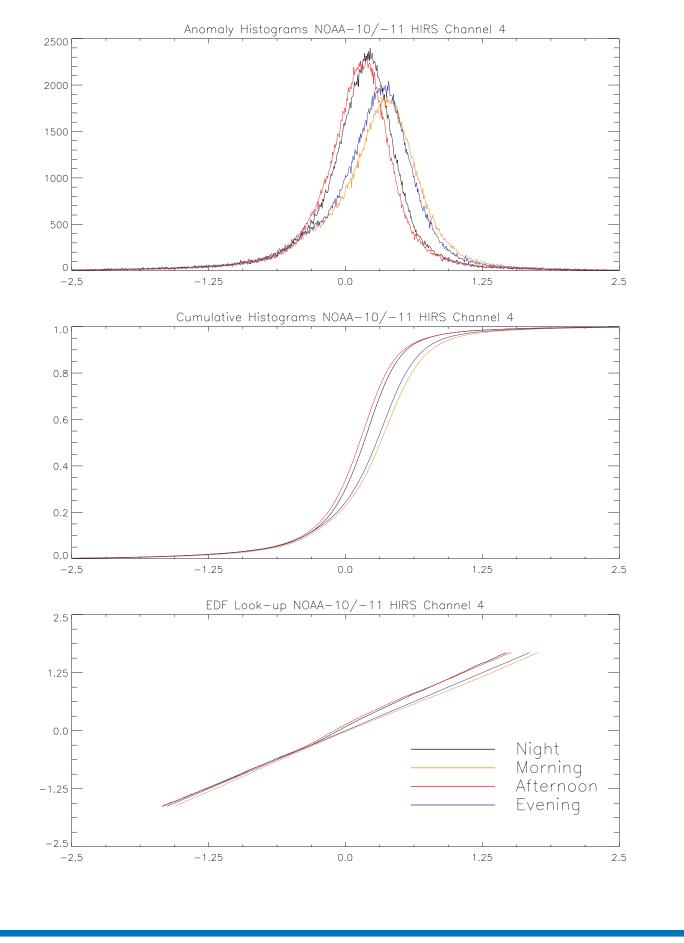


Upper tropospheric humidity (UTH) product is currently available. Retrieval used the HIRS Pathfinder clear-sky bias corrected data.

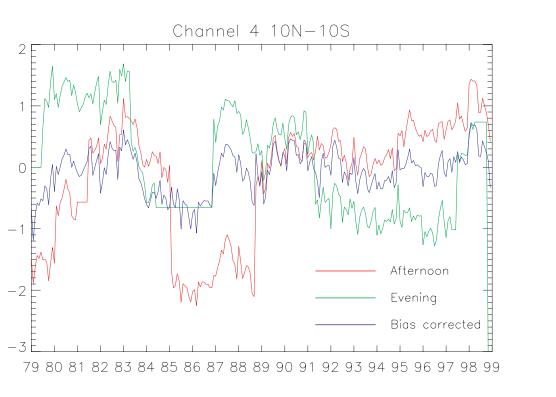
INTERSATELLITE BIAS



Intersatellite bias has been shown to have large effects on time series of temperature channels. Temperature channels (3-7,13-15) are most affected since these channels reside on the edge of a transmission line needed for profiling. Therefore, small changes in the filter response and the central wavenumber can cause significant sensitivity in brightness temperature. Modeled intersatellite bias indicates that changes in the central wavenumber between satellites causes the largest bias between satellites. However, modeled bias does not always explain the observed bias. Relative to NOAA-10, the intersatellite bias between model and observations can be of opposite sign (NOAA-14) or significantly different (NOAA-5 = TIROS-N).



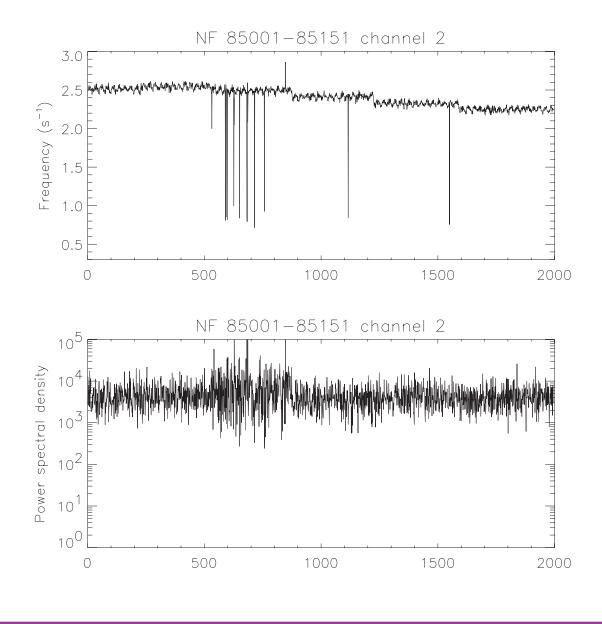
An empirical approach is used here to account of intersatellite bias. This approach uses cumulative histograms of the anomaly data from observations collected over the same time period for each of four daily overpass times. Histograms are shown here of the channel 4 data collected during the NOAA-10/NOAA-11 time period. The histograms for NOAA-10 indicate a warmer median value than NOAA-11 but a very similar structure for the negative anomalies. Cumulative histograms show this even better. The adjustment creates a lookup table shown in the bottom diagram so that all the observations can be adjusted to the evening orbit. This approach differs from a mean bias correction since this form of adjustment accounts for nonlinearities between the histograms.



The results of the adjustment are shown above. The red and green lines show the 20-yr time series of the afternoon and evening overpasses for channel 4 anomalies. Intersatellite jumps occur in both time series particularly in the 1980s. The blue curve gives the empiricallyadjusted channel 4 result.

THE FUTURE

The next step in processing will involve further work in removing known biases. These biases include (1) noise generated from electronic crosstalk from the SSU instrument, (2) signal loss from absorption at frequencies in the channel 10 band due to the coating on the mirror for the early satellites, (3) errors in the 1b calibration coefficients for the early satellites. In addition to accounting for these biases, a cloud retrieval method (Wylie and Menzel, 1999) will be introduced to our process so that future data sets will include cloud information.



An example of the SSU noise introduced into the HIRS data. Power spectra analysis was performed on each cold calibration line for a 151-day period. The peak of each power spectrum is given for all the calibration lines as a time series. The peak frequency is near 2.4 cycles/sec and has significant power. Removal of this noise from the HIRS data is one goal for the next stage of processing.

These data are slated for use in programs such as GEWEX, CLIVAR, and GCOS. While the data are currently available for the scientific community directly from ETL, our goal is to make them available at a DAAC in the near future.